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20 August 1968

MEMORANDUM FOR: Director of Special Activities

SUBJECT: S-1010/S-901 Suit Comparisons

REFERENCE: [redacted] dated 9 Aug. 1968
dated 15 Aug. 1968

1. This memorandum is for your information.

2. As mentioned on various occasions, including the 5 August 1968 Suit Meeting at Detachment G, the "S-901" (i.e., [redacted] type suit) was not selected as a candidate suit for use in the U-2R. The starting point for design of the S-1010 suit was the S-901J suit used in the SR-71. For the record, the following paragraphs will review the reasons for these decisions, design goals established, the development history and initial evaluations.

3. Suit Selection History

A. The first recorded mention of use of a full pressure suit in the U-2R was made 17 January 1966 in a letter from C. L. Johnson to OSA accompanying the U-2R proposal which stated, "We are enlarging the cockpit and planning to use the latest pressure suit to provide better pilot comfort for such long missions".

B. In September 1966 it became known that LAC planned on using the escape system/seat kit/oxygen system combination from the SR-71 as the most advanced systems for the U-2R. The S-901J PPA was designed from the outset of development of the SR-71 "Stabilized Seat" as an integral part of this total life support system. At this point in time, higher authority (NRO/Comptroller specifically) was not convinced that full pressure suits would be required, and when this requirement was finally validated, the same authority stated that no new "development" would be required. Therefore, because the S-901J was the latest design in PPA's and

USAF
review(s)
completed.

NRO review(s) completed.

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because it was an integral part of the planned escape/life support system for the U-2R, it was tentatively selected to be the suit for use in the U-2R. The only disputed point at this time was whether "standard size" suits would be purchased, as in the SR-71 program, or whether "custom-fitted" suits would be used, with the decision to be based on costs [redacted]

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C. In the period September-November 1966 the undersigned obtained detailed information on the S-901J system through visits to Beale AFB, Edwards AFB, David Clark Co., and LAC. This office already had detailed information regarding all S-901 suits, preceeding the S-901J, from the OXCART program. Pilot acceptance, advantages, disadvantages and maintenance features of this system as well as preceeding PPA's were explored. The Detachment G director of life support [redacted] was involved in all of these information-seeking efforts.

D. During the period 28-30 November 1966 three Detachment G pilots [redacted] two SAC pilots (Milam, Davis) and one LAC pilot (Powers) were fitted in standard sized S-901J suits and participated in the cockpit mockup review. Five life support representatives were involved, who devoted their full attention to pilot responses to the S-901J PPA [redacted]

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The conclusions reached following this session were as follows:

- (1) Standard sized suits were unacceptable.
- (2) Un-modified S-901J suits were unacceptable.
- (3) Desired features for a U-2R full pressure suit would include:
 - a. A completely integrated PPA donned as one suit (instead of separate outer cover as in the S-901J).
 - b. Reduced bulk of PPA (no need for aluminized outer cover).
 - c. Enlarged helmet (internal dimensions were inadequate for some pilots, i.e., [redacted]).

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- d. A useful feeding port.
- e. A urine elimination system.
- f. Head flexibility similar to the partial pressure suit (i.e., flexible section in neck area).
- g. Ability to doff the PPA unaided.
- h. Improved neck ring arrangement so that head was not angled upwards when turning the head laterally in the pressurized state.
- i. Improved microphone positioning.

E. Previous and concurrent investigations of S-901 E, F, G, H, J and S-970 utilization and acceptance in other programs established additional design goals for a U-2R PPA as follows:

- (1) Reduce helmet weight to maximum extent (all experience with above PPA's indicated that 4-6 hours was maximum duration tolerable with existing helmet weights).
 - (2) Eliminate hoses which passed internally from suit to helmet in neck ring area (these were a constant source of discomfort).
 - (3) Eliminate external hoses, commo cords, etc., from helmet (drag and potential snagging were cited as problem areas).
 - (4) Improve flotation garment for higher and improved position in the water.
 - (5) Use a dark color for outer layer of PPA to eliminate glare in cockpit instruments, etc.
 - (6) Clean up the arrangement of hoses on the front of the PPA.
 - (7) Utilize a full head liner suspension system rather than a crown/nock pad/ear cup system. 25X1
- Boale AFB was in the process of locally modifying their S-901J helmets to this configuration at that time.

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F. During December 1966 a request for proposal outlining these design goals was submitted to the David Clark Company and by 1 January 1967, a technical proposal and cost estimate were submitted to OSA. However, it required the period from January through April 1967 to convince budget authorities that a development effort was required and obtain necessary funding. Approval was obtained on the basis that the efforts were modifications of an existing PPA and that development of an entirely new PPA was not to be undertaken.

4. Development History and Initial Evaluations

A. Although official approval and funding was delayed, the David Clark Co. proceeded with development of concepts, engineering, and bread-board models which the undersigned followed closely. With official approval and funding obtained maximum effort was made to develop, complete and evaluate the S-1010 prototype PPA on an expedited basis to meet the aircraft/pilot training/IOC schedule then in existence.

B. The prototype S-1010 PPA was completed in October 1967 and initial chamber evaluations were conducted immediately thereafter with the undersigned as test subject. The decision to act as test subject was based on intimate knowledge of other PPA's for a comparison basis (including the standard USAF "dash-two" PPA, all S-901 series suits, USN "Mark-IV" suits, Gemini suits as well as partial pressure suits of various designs). In addition, the prototype S-1010 was most closely sized for wear by the undersigned and proper fit of any PPA is known to be the key to its effectiveness and acceptance. The only other approach would be to build a prototype for each pilot (or a selected group to eliminate strictly personal preferences) for evaluation, which was and is not feasible economically or technically. The chamber flight evaluations consisted of three runs, one of 1½ hours duration, one of 4½ hours and one of 12 hours duration. The results indicated that, with minor additional changes and improvements, all design goals were met. After 13½ hours of continuous wear, there was no helmet weight/mobility induced fatigue in the test subject, who, in comparison

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to a pilot subject, is not used to wearing a helmet on a "daily" basis. The full report of these evaluations was provided to Detachment G for review and retention. Following the minor changes made as a result of the initial evaluations, the undersigned presented a demonstration of the prototype S-1010 PPA to Detachment G and LAC personnel in November 1967 and discussed the features of the S-1010 in great detail with representative pilots (particularly [redacted]). The prototype was also compared at this time with Power's "interim S-901" type suit. A cockpit evaluation was conducted with [redacted] as observers and the results were reported by [redacted]. Production go-ahead was given on the basis of these evaluations.

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C. In line with Headquarters Life Support's concepts, the fitting and chamber session for each pilot in his own PPA was to serve as both part of the custom fitting process as well as a follow-on evaluation program. Each pilot has been "debriefed" following this initial exposure to his S-1010 to obtain detailed response to all the features of the S-1010 with particular attention paid to the areas of known trade-offs or compromises required to achieve the design goals. These individual responses are recorded and maintained at the contractors, Headquarters and Detachment G for guidance in improving fit, comfort, function and acceptance of the S-1010 and as a key to possible requirements for further modifications and product improvement.

5. Continuing Evaluation Efforts

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A. From the initial flight of [redacted] in his S-1010 PPA, pilot evaluation has been solicited, again with emphasis on areas of known trade-offs, in the form of evaluation records designed by Headquarters life support and supplied directly to Detachment G life support. As stated on these evaluation forms, the information provided by each pilot for each S-1010 flight is needed to determine (1) equipment useage history, (2) problem areas requiring improvement, (3) equipment deficiencies requiring repair or replacement, and (4) confirmation of basic design goals.

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Each pilot should evaluate his equipment based on his experience, knowledge and preferences. These evaluations are the key to the success of the overall S-1010 PPA program. However, time is required to completely evaluate all aspects, just as has been the case with all PPA's in other programs and with the partial pressure suit at the start of the U-2 program. Initial evaluations are important, but must be analyzed in terms of newness and unfamiliarity of the equipment. It can be verified from many pilots' memories that upon initial exposure to the partial pressure suit, a general first impression was that "you can't fly an airplane in this thing". Time, experience and detailed attention to improving fit certainly disproved such initial impressions. Provided "safety-of-flight" is not a factor, which this Headquarters believes to be the case, a formal and continuing evaluation must be provided to allow the same time/experience/familiarity related process to occur.

6. Conclusions and Recommendations

A. The S-1010 PPA is the assembly designed to satisfy all requirements for use in the U-2R. Comparison with other assemblies at this time is not required, necessary or valid.

B. A continuing formal evaluation of each pilot's S-1010 PPA is required to insure that optimum fit and function is obtained and appropriate modifications, changes and product improvements can be planned and obtained. Initial evaluations are valid only when compared with evaluations based on more experience and familiarity.

C. Following completion of the present refit/cockpit evaluation exercise being conducted at Detachment G for every pilot, a formal recording and reporting system will be adopted so that all interested and responsible groups will be able to follow the on-going evaluations of the S-1010.

/s/

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